AUTOMATIC TRACKING AND MONITORING INCLUDING IMMEDIATE FIRE DETECTION FOR DANGEROUS GOODS IN TUNNELS

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ABSTRACT
Transport of dangerous goods across tunnels is at present a complicated paper based process. The proposed method involves smart card storage media, transponders to read the smart card from a roadside unit to track vehicles as they travel on their route, sensors to detect potential fires in vehicles within seconds and mobile control devices to verify proper function of the on-board equipment. The procedure is simplified and can be considered a safety improvement as the speed of transport increases, and, hence, the number of required vehicles on the road and their presence in dangerous locations is reduced.

1. INTRODUCTION
Catastrophes that have happened in tunnels in the recent past have directed attention of politics to address the problem, and this has lead to an open attitude of infrastructure operators to look for possibilities to re-engineer their current operating procedures.

The particular focus in this article is on transport of hazardous goods, though in principle of course all vehicles could be tracked using the same procedure without any hold-up in dangerous locations.

A study is currently going on in a major inner-city tunnel in Austria, to test the advantages of automatic tracking of hazardous goods inside tunnels.

The current procedure requires trucks with hazardous loads, to stop at tunnel entrances and wait for an accompanying vehicle. The type of good, container, planned route, the potential risks and the allowed treatments in case of accidents and fires must be registered manually with the authority.

It goes without saying that the process is time consuming and unpopular among freight forwarders. In addition, it keeps vehicles on the street for a long time and is therefore a safety risk component on its own.

2. INFORMATION AND COMMUNICATION SYSTEM
In the study, all information on hazardous freight is stored on a contact less smart card (contact cards suffer from slot-related problems in rugged environments) and the card is inserted in an On-Board Unit (the "OBU"), which transmits all data to the roadside reader when interrogated.

The OBU is glued to the inside of the windshield and requires line of sight to the roadside units. The communication is performed employing a novel technology of infrared light communication, which works under all weather conditions including direct sunlight, snow and fog. The OBU consumes very low standby power, which enables operation of the device
on a single battery for years. This technology has been invented as one of the results of the Austrian Space Program (Austromir) and has been published elsewhere.

Fig. 1: On-Board Unit with and without Smart Card

The interrogation may take place at particular spots like tunnel entry, tunnel ventilation segment change, tunnel exit, change of legal district responsibility, entry into city, border crossing point, arrival at destination etc. Inside the tunnel and in other suitable locations, the vehicle is tracked by video cameras, and registration with checkpoints is matched with the pictures in the backend system.

Fig. 2: Checkpoint for Hazardous Goods Transport (Study)

In case of an emergency, it is exactly known in what section which material is present and what else is inside the tunnel at any given moment.

The smart card can be programmed using a desktop or a hand-held device, and activation takes place after the authority has issued a digital certificate. The authority still has to verify that sufficient resources are nearby in case of a disaster. The programmed smart card plus OBU can also be handed out at border checkpoints in case of foreign vehicles.
It is also possible to check the validity of the registration via a hand-held device from up to 100m away without stopping the vehicle.

The system is also understood as a complimentary solution to other programmes based on GPS/GSM, which would not work inside tunnels or where very exact location is required.

3. **FIRE AND SMOKE DETECTION**

Additional safety can be achieved if fire and smoldering-fire reliably can be detected in an early state. The main problem is caused by the fact that cars are moving objects, even the burning one in some cases. To detect a fire, sensors available today’s needs time in the scale of minutes. Within a research project, Efkon has developed a novel Fire and Smoke Detection System, which is able to detect hazardous situations within 5 to 10 seconds and vehicle-speeds up to 35 m/s. The sensors are connected in form of a corresponding sensor network, which is able to share all the information and correlate the data with the moving vehicle. This system is still a prototype.
4. CONCLUSIONS

The study has shown that vehicles can reliably be detected and tracked in discrete locations using infrared light communication and that real-time information about hazardous goods in tunnels can be an efficient alternative to the currently used procedures. The expected improvement in safety would probably come for a low cost or even for no cost to the overall economy as vehicle numbers are reduced and personnel can be reduced while still achieving higher overall safety.

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